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The Replacement of the Potentials as a Consequence of the Limitations Set by the Law of the Self variations on the Physical Laws

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***Abstract*— the law of self variations determines quantitatively a slight increase of the rest masses and electric charges of the material particles as the common cause of quantum and cosmological phenomena. The Lienard-Weichert electromagnetic potentials are compatible with Special Relativity, but are not compatible with the law of self variations. In this article we present the electromagnetic potentials that are compatible with the law of self variations. We note that equations compatible with the law of self variations are also compatible with the Lorentz-Einstein transformations. The electromagnetic potentials of the self variations are decomposed into two independent pairs of scalar-vectorial potentials. One pair gives the electromagnetic field that accompanies the electric charge in its motion. The other pair gives the electromagnetic radiation.**

***Index Terms*— Lienard-Weichert potentials, self variations, special relativity.**

I. INTRODUCTION

Our current Physical knowledge, in combination with our mathematical calculations [1], allows us to propose the law of the self variations as the common cause of quantum and cosmological observations. The knowledge we possess in the area of Electromagnetism played a crucial role in the quantitative determination of the self variations, i.e. in the formulation of the law of self variations. All the mathematical equations that are compatible with the law of the self variations are also compatible with the Lorentz-Einstein transformations. However, the opposite does not hold. The Lienard-Weichert electromagnetic potentials are compatible with the Lorentz-Einstein transformations, but are not compatible with the law of self variations. In this article we present the potentials that are compatible with the law of self variations and supplant the Lienard-Weichert potentials.

II. THE ELECTROMAGNETIC POTENTIALS IN THE MACROCOSM

We consider an electric point charge q moving arbitrarily in an inertial reference frame $Oxyzt$, as depicted in Fig. 1. We denote $\mathbf{r} = \overrightarrow{EA}, r = \|\mathbf{r}\|$ and

$$\boldsymbol{\upsilon} = c\frac{\mathbf{r}}{r} \qquad (1)$$

Where c is the speed of light in vacuum.

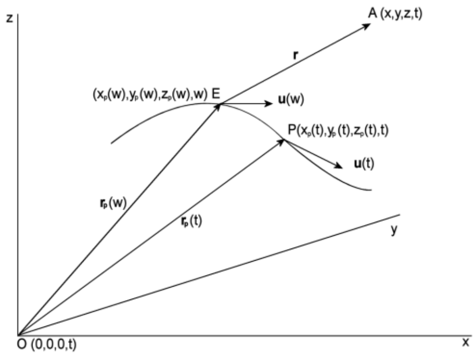

Fig 1: An arbitrarily moving electric point charge at time t. The source of the electromagnetic field at point $A(x,y,z,t)$ is the electric charge q positioned at $E(x_p(w),y_p(w),z_p(w),w)$ at the decelerating time $w = t - \frac{r}{c}$.

Fig. 1 refers to the point in time t when the electric charge q is at position $P(x_p(t),y_p(t),z_p(t),t)$. The source of the electromagnetic field at point $A(x,y,z,t)$ is the electric charge q from position $E(x_p(w),y_p(w),z_p(w),w)$ at the decelerated time

$$w = t - \frac{r}{c} \qquad (2)$$

The electric field $\boldsymbol{\varepsilon}$ and the magnetic field $\mathbf{B}$ at point $A(x,y,z,t)$ are given by the pair $(V,\mathbf{A})$ of the scalar potential V and the vector potential $\mathbf{A}$ respectively, through equations

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$$\boldsymbol{\varepsilon} = -\nabla V - \frac{\partial \mathbf{A}}{\partial t} \quad (3)$$

$$\mathbf{B} = \nabla \times \mathbf{A} \quad (4)$$

where $\nabla V = \begin{bmatrix} \frac{\partial V}{\partial x} \\ \frac{\partial V}{\partial y} \\ \frac{\partial V}{\partial z} \end{bmatrix}$ και $\nabla \times \mathbf{A} = curl\mathbf{A}$.

Using the symbols of Fig. 1, the electric potential V and the vector potential $\mathbf{A}$ are given by equations [1]

$$V = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2} + \frac{q\left(\boldsymbol{\upsilon}\cdot\boldsymbol{\alpha}\right)}{4\pi\varepsilon_0 c^3\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2} \quad (5)$$

$$\mathbf{A} = V\frac{\boldsymbol{\upsilon}}{c^2} \quad (6)$$

where $\mathbf{u} = \mathbf{u}(w)$ is the velocity of the electric charge at point $E\left(x_p(w), y_p(w), z_p(w), w\right)$.

The intensity of the electric field $\boldsymbol{\varepsilon}$ and the intensity of the magnetic field $\mathbf{B}$ resulting from the above potentials through equations (3) and (4) at point $A(x,y,z,t)$, are [1]:

$$\boldsymbol{\varepsilon} = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r^2\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^3}\left(\frac{\boldsymbol{\upsilon}}{c}-\frac{\boldsymbol{u}}{c}\right) + \frac{q}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2}\left[\frac{\left(\frac{\boldsymbol{\upsilon}}{c}\boldsymbol{\alpha}\right)}{1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}}\left(\frac{\boldsymbol{\upsilon}}{c}-\frac{\boldsymbol{u}}{c}\right)-\boldsymbol{\alpha}\right] \quad (7)$$

$$\boldsymbol{B} = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r^2\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^3}\frac{\boldsymbol{u}}{c}\times\frac{\boldsymbol{\upsilon}}{c} + \frac{q}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)}\left[\frac{\left(\frac{\boldsymbol{\upsilon}}{c}\boldsymbol{\alpha}\right)}{1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}}\left(\frac{\boldsymbol{u}}{c}\times\frac{\boldsymbol{\upsilon}}{c}\right)-\frac{\boldsymbol{\upsilon}}{c}\times\boldsymbol{\alpha}\right] \quad (8)$$

As it is already known [2]-[4], we also arrive at equations (7) and (8) from the Lienard-Wiechert electromagnetic potentials:

$$V_{LW} = \frac{q}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\mathbf{u}}{c^2}\right)} \quad (9)$$

$$\mathbf{A}_{LW} = V_{LW}\frac{\mathbf{u}}{c^2} = \frac{q}{4\pi\varepsilon_0 c^2 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\mathbf{u}}{c^2}\right)}\mathbf{u} \quad (10)$$

where $\mathbf{u} = \mathbf{u}(w)$ is the velocity of the electric charge at point $E\left(x_p(w), y_p(w), z_p(w), w\right)$.

If we do not take into account the self variation of the electric charge, the pair of potentials given in (5)-(6), as well as the pair of potentials given in (9)-(10), give the same equations (7)-(8) for the electromagnetic field. If, however, we do consider the law of the self variations [1], while the potentials (5)-(6) still give equations (7)-(8), the potentials (9)-(10) give from equations (3)-(4)

$$-\nabla V_{LW} - \frac{\partial \mathbf{A}_{LW}}{\partial t} = \boldsymbol{\varepsilon} + \frac{1}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\mathbf{u}}{c^2}\right)}\cdot\left(\nabla q + \frac{\partial q}{\partial t}\frac{\mathbf{u}}{c^2}\right) \quad (11)$$

$$\nabla \times \mathbf{A} = \mathbf{B} + \frac{1}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\mathbf{u}}{c^2}\right)}\nabla q \times \frac{\mathbf{u}}{c^2} \quad (12)$$

with vectors $\boldsymbol{\varepsilon}$ and $\mathbf{B}$ as given by equations (7) and (8).

The law of self variations gives that at point $A(x,y,z,t)$ it is

$$\nabla q + \frac{\partial q}{\partial t}\frac{\mathbf{u}}{c^2} \neq 0 \quad (13)$$

therefore, equation (11) does not correctly express the electric field $\boldsymbol{\varepsilon}$ at point $A(x,y,z,t)$. More generally it holds that

$$\nabla q \times \mathbf{u} \neq 0 \quad (14)$$

and, therefore, equation (12) does not correctly give the magnetic field $\mathbf{B}$ at point $A(x,y,z,t)$, either. Consequently, the Lienard-Wiechert electromagnetic

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potentials are not compatible with the self variations. This is why they are replaced by the potentials given in (5)-(6). If we denote by L the set of equations that are compatible with the Lorentz-Einstein transformations, and by S the set of equations compatible with the self variations, then it holds that:

$$S \subset L \tag{15}$$

One such example are the Lienard-Wiechert potentials. They belong to set L, but they do not belong to set S. The law of self variations imposes more severe restrictions on the equations describing physical laws, than those imposed by Special Relativity. The electromagnetic potentials of the self variations (5)-(6) have two fundamental characteristics. The first is that they are decomposed into two individual pairs of potentials

$$V_u = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2} \tag{16}$$

$$\boldsymbol{A}_u = V_u \frac{\boldsymbol{\upsilon}}{c^2} \tag{17}$$

and

$$V_\alpha = \frac{q\left(\boldsymbol{\upsilon}\cdot\boldsymbol{\alpha}\right)}{4\pi\varepsilon_0 c^3\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2} \tag{18}$$

$$\boldsymbol{A}_\alpha = V_\alpha \frac{\boldsymbol{\upsilon}}{c^2} \tag{19}$$

The $\left(V_u, \mathbf{A}_u\right)$ pair gives, through equations (3)-(4), the electromagnetic field $\boldsymbol{\varepsilon}_u, \mathbf{B}_u$ that accompanies the electric charge in its motion:

$$-\nabla V_u - \frac{\partial \mathbf{A}_u}{\partial t} = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r^2\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^3}\left(\frac{\boldsymbol{\upsilon}}{c}-\frac{\boldsymbol{u}}{c}\right) = \boldsymbol{\varepsilon}_u \tag{20}$$

$$\nabla \times \mathbf{A}_u = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r^2\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^3}\frac{\boldsymbol{u}}{c}\times\frac{\boldsymbol{\upsilon}}{c} = \mathbf{B}_u \tag{21}$$

The $\left(V_a, \mathbf{A}_a\right)$ pair gives, again through equations (3)-(4), the electromagnetic radiation:

$$-\nabla V_a - \frac{\partial \mathbf{A}_a}{\partial t} = \frac{q}{4\pi\varepsilon_0 c^2 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2}\left[\frac{\left(\frac{\boldsymbol{\upsilon}}{c}\boldsymbol{\alpha}\right)}{1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}}\left(\frac{\boldsymbol{\upsilon}}{c}-\frac{\boldsymbol{u}}{c}\right)-\boldsymbol{\alpha}\right] = \boldsymbol{\varepsilon}_a \tag{22}$$

$$\nabla \times \mathbf{A}_a = \frac{q}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)}\left[\frac{\left(\frac{\boldsymbol{\upsilon}}{c}\boldsymbol{\alpha}\right)}{1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}}\left(\frac{\boldsymbol{u}}{c}\times\frac{\boldsymbol{\upsilon}}{c}\right)-\frac{\boldsymbol{\upsilon}}{c}\times\boldsymbol{\alpha}\right] = \mathbf{B}_a \tag{23}$$

The second characteristic of the electromagnetic potentials of the self variations concerns the $\left(V_a, \mathbf{A}_a\right)$ pair. According to equations (18) and (19), the electromagnetic potentials that give the electromagnetic radiation are independent of the distance r of point $A\left(x,y,z,t\right)$ from the electric charge q. In the microcosm, the law of self variations [1] is related to the quantum phenomena. This is why we characterized the electromagnetic potentials (5)-(6) as macroscopic. These potentials replace the Lienard-Wiechert potentials for the reasons we already mentioned.

IV. DISCUSSION

The Special Theory of Relativity sets limitations on the mathematical expressions of the physical laws, which have to be invariant with respect to the Lorentz-Einstein transformations. The Law of the Self variations, as well as the totality of the equations of the Theory of Self variations, are invariant under the Lorentz-Einstein transformations. This is a direct consequence, since the formulation of the mathematical expression of the Law of the Self variations has been conducted under the assumption of the correctness of the Special Theory of Relativity. The Special Theory of Relativity restricts in

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such a decisive way any variation of the rest mass or the electric charge of a material particle that this variation can be done in only one way which is the Law of the Self variations. The relation between the Law of the Self variations and the Special Theory of Relativity is even deeper. The generalized photon which is the most immediate consequence of the Law of the Self variations has itself as a consequence a continuous exchange of signals between material particles with the velocity of light. Thus the exchange of signals with velocity c between two observers is not merely a hypothesis which may be stated for the derivation of the Lorentz-Einstein transformations, but a continuous physical reality. This physical reality is expressed by a large set of theorems and corollaries of the Theory of Self variations. By a lucky coincidence Einstein was asked for the choice of the exchange of signals with velocity c between two observers, in order to derive the Lorentz-Einstein transformations. Namely about the fact that two observers exchange sonic or other kinds of signals with a velocity $u \neq c$ the resulting transformations are wrong. So, we know the answer he provided: “The correctness of the Lorentz-Einstein transformations are justified by the outcome. These transformations lead to correct results, in contrast to other candidate transformations, which lead to wrong conclusions.” The development of the Theory of Self variations shows that the exchange of signals with velocity c via generalized photons is a continuous physical reality. To this physical reality the Lorentz-Einstein transformations owe their correctness. Material particles constantly exchange generalized photons, i.e. they constantly exchange information with velocity c. The Theory of Self variations imposes additional constraints on the mathematical formulation of the physical laws, beyond the ones imposed by the Special Theory of Relativity. The physical laws have moreover to be compatible with the self variations. The present article is a classical example about the consequences of the additional constraints imposed by the Theory of Self variations on the mathematical formulation of physical laws. The Liénard-Wiechert potentials are compatible with the Special Theory of Relativity and they are also invariant under the Lorentz-Einstein transformations. On the other hand, they are not compatible with the self variations. For this reason they are replaced by the potentials of the self variations, as they are presented in the present article. The self variations potentials do not simply replace the Liénard-Wiechert potentials. The replacement induces fundamental consequences for the Theory of Electromagnetism. Instead of the one couple of scalar- vector potentials as in the Liénard-Wiechert potentials, we have derived two independent couples. The first couple gives the electromagnetic field which accompanies the electric charge during its motion. This couple is inversely proportional to the distance r from the electric charge. The other couple of scalar- vector potentials describe the electromagnetic radiation. This couple is independent from the distance r from the source. As the energy of the electromagnetic radiation is expressed by the introduction of the quantum of the photon, in a similar manner the potential giving the electromagnetic radiation can be expressed by a “quantum of potential” which is independent of the distance from the source. The present article is a characteristic example about the consequences of the self variations on the mathematical formulation of the physical laws.

V. CONCLUSION

The one couple of scalar- vector potentials

$$V_u = \frac{q\left(1-\frac{u^2}{c^2}\right)}{4\pi\varepsilon_0 r\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2}$$

$$\boldsymbol{A}_u = V_u\frac{\boldsymbol{\upsilon}}{c^2},$$

gives the electromagnetic field which accompanies the arbitrarily moving electric point charge during its motion. The other couple of scalar-vector potential

$$V_\alpha = \frac{q\left(\boldsymbol{\upsilon}\cdot\boldsymbol{\alpha}\right)}{4\pi\varepsilon_0 c^3\left(1-\frac{\boldsymbol{\upsilon}\cdot\boldsymbol{u}}{c^2}\right)^2}$$

$$\boldsymbol{A}_\alpha = V_\alpha\frac{\boldsymbol{\upsilon}}{c^2},$$

gives the electromagnetic radiation emitted by the arbitrarily moving electric point charge. The potentials of the self variations are invariant under the Lorentz-Einstein transformations, while they are also compatible with the self variations. The potential giving the electromagnetic radiation does not depend on the distance r from the source-point charge of radiation.

REFERENCES

[1] Manousos, E., “Mass and charge self variation: A Common Underlying Cause for Quantum Phenomena and Cosmological Data”, Progress in Physics, Vol. 9 (3), pp.73-141, July 2013.

[2] Griffiths, D, Introduction to Electrodynamics, Prentice Hall, 1999.

[3] Wangsness, R. K., Electromagnetic Fields, John Wiley, 1986.

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Volume 3, Issue 10, April 2014
[4] Lorrain, P., Corson, D., Electromagnetic Fields and Waves, W.H. Freeman & Company, 1970.